Hazardous Liquids Airborne Lidar Observation Study (HALOS)
Quarterly Status and Progress Report
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In this project, with support of DOT/PHMSA, ITT Industries intends to extend its current Airborne Natural Gas Emission Lidar (ANGEL) technology to create a conceptual design for an airborne ha zardous liquid leak detection system. The major deliverable for this phase of the study is the "Target Characterization Report". This report consists of four distinct sections: Overview of Hazardous Liquids Pipelines; Spectral Characteristics of the Target; Plume Characteristics; and an Airborne Platform Trade Study. An overview of each of these sections follows.

Overview of Hazardous Liquids Pipelines.

This portion of the HALOS project is in progress. During this phase of the project a variety of different hazardous liquids were examined. Spectrally the hydrocarbons can be divided into propane, gasoline-type hydrocarbons (all grades of gasoline and aviation gas) and diesel- fuel like hydrocarbons (diesel fuel, Jet A, and kerosene). It was observed that liquid hydrocarbons have MWIR absorption spectra similar but not identical to vapor spectra. Upcoming work includes an overview of the hazardous liquid pipelines in the United States, a survey of current leak detection methods, collection of both actual and modeled data on the surface spread of liquid hydrocarbons, and a study of phase behavior of hydrocarbons leaking from an underground pipe.

Spectral Characteristics of the Target

Major progress was made in this portion of the study. One major accomplishment in this portion of the study was the design and construction of an MWIR illumination source and creation of a field-portable MWIR FTIR spectrometer. Following construction of the spectrometer, spectra of a variety of synthetic and natural materials was collected. Initial collections were conducted in the lab followed by a variety of collects outside. Spectral properties of a pipeline right-of-way will likely be seasonally dependant. After discussion with the COTR, he HALOS team has decided to spread the creation of the spectral library over the course of the year to allow the creation of a spectral library to reflect seasonal variability.

Plume Characteristics

Work during this phase of the project consisted largely of numerical plume modeling of propane, gasoline, and diesel fuel vapors in the air. One observation resulting from this work is that the plumes from small propane leaks behave very much like methane (natural gas) plumes. Propane and methane plumes are both very sensitive to the leak rate and speed of the wind. Plumes from gasoline and diesel fuel leaks are complex and are highly dependent on the evaporation of the liquid. Evaporation of the liquid is largely driven by surface area of the liquid, solar illumination, and temperature. Gasoline was modeled to be significantly more volatile than diesel fuel resulting in significantly larger airborne plumes. Numerical modeling efforts will be augmented with a series of wind tunnel validation studies over the next few months.

Airborne Platform Trade Study

This study is complete and provides an overview of Unmanned Aerial Vehicles (UAVs) and manned Light Fixed Wing Aircraft (LFWA) which potential platforms for a future HALOS sensor system. This study is based on the size, weight, power requirements, and operational parameters of the existing ANGEL natural gas detection system compared with the calculated capabilities of each aircraft.

In addition to the research leading to the creation of this report, ITT hosted a HALOS Kickoff Meeting with the technical COTR in Rochester. During this 2–day meeting, Samuel Hall from DOT toured the ITT Industries Optical Manufacturing facilities, visited the ITT Industries Hanger to observe the ANGEL aircraft and sensor, and met with the HALOS team of scientists and engineers for a day- long overview of progress and discussion of ongoing work.

The ANGEL system has been built to remotely detect, quantify, and precisely locate hydrocarbon gas leaks from natural gas transmission pipelines. This system uses advanced lasers that have been spectrally tuned to detect natural gas. In addition to leak detection and quantification, the ANGEL system's automatic pointing and scanning subsystem will be leveraged. Finally, in this initiative the ITT team will also utilize ANGEL's high-resolution digital color camera subsystem that allows the identification of pipeline threats and risks and provides visual context to the leak detection data.

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